PRAIRIE DOG COLONY ATTRIBUTES AND ASSOCIATED VERTEBRATE SPECIES

Tim W. Clark[1], Thomas M. Campbell III[2], David G. Socha[3], and Denise E. Casey[2]

Abstract.— A survey of colony attributes and associated vertebrates on black-tail (*Cynomys ludovicianus*), Gunnison's (*C. gunnisoni*), and white-tail (*C. leucurus*) prairie dogs was made. A belt transect 1.6 km wide and 13,334 km long from Hobbs, New Mexico, to the Utah-Wyoming state line was surveyed. There were 47 colonies located (4760 ha comprising 2.2 percent) in the belt. Intercolony distances varied significantly. Three black-tail towns averaged 33 ha in area (SD = 26, range 10–61), 11 Gunnison's averaged 46 ha (SD = 43, range 16–150), and 33 white-tail towns averaged 125 ha (SD = 200, range 0.2–958). Badger activity was positively and significantly correlated to colony size and number of burrow openings on Gunnison's and white-tail towns. There were 107 vertebrate species and subspecies (one amphibian, 25 reptiles, 51 birds, 30 mammals) observed on prairie dog colonies. Results of our surveys are compared with prairie dog studies elsewhere. The role of prairie dogs and relationships to some vertebrates species are discussed.

This paper describes results of a survey of colony characteristics and associated vertebrate species for three prairie dog species in Utah, Colorado, and New Mexico.

Study Area

Prairie dog colonies surveyed were in a belt transect (1.6 km wide and 1334 km long) beginning near Hobbs, New Mexico, and ending on the Utah-Wyoming state line (Fig. 1). The transect generally followed an existing pipeline corridor. The prairie dog species encountered were: black-tail (*Cynomys ludovicianus*), Gunnison (*C. gunnisoni*), and white-tail (*C. leucurus*). These species collectively occupied many vegetation-physiographic types. Overall, black-tail colonies were in shortgrass prairie with *Bouteloua* sp. and *Buchloe dactyloides* with scattered *Opuntia imbricata*. Gunnison colonies were associated with *Juniperus monosperma*, shrubs, and *O. imbricata*, as well as a variety of forbs and grasses. White-tail colonies had an overstory of *Artemisia* sp. and a diverse understory of forbs and grasses.

Methods

All prairie dog colonies were aerially located and mapped onto U.S. Geological Survey 7.5 and 15 minute maps. Beginning in June 1980, near Hobbs, New Mexico, and working north to Wyoming, each town was visited, precisely mapped, and inventoried in detail. Surveys followed guidelines designed for black-footed ferret (*Mustela nigripes*) searches (Clark and Campbell, in preparation), and allowed for a concomitant general survey of vertebrate species.

Diurnal surveys began with a 1-hr observation of the colony with binoculars and spotting scopes from vantage points. Similar predusk observation periods were also conducted. Walking surveys were made immediately following morning surveys. Each colony was thoroughly walked by up to 12 people simultaneously. Each person moved back and forth within a 30 m wide area and examined all prairie dog burrow openings, mounds, and adjacent areas, as well as the overall surface of the colony. Each burrow examined was marked with a footprint to assure complete, nonoverlapping coverage. Data recorded included: number of burrow openings (5 cm or larger in diameter); number of burrow openings in "active" use, where possible to determine; number of badger excavated holes; number of plugged burrow openings; number of km walked;

[1]Department of Biology, Idaho State University, Pocatello, Idaho 83209.
[2]Biota Research and Consulting, Inc., P.O. Box 2705, Jackson, Wyoming 83001.
[3]Department of Zoology, University of Wisconsin, Madison, Wisconsin 53706.

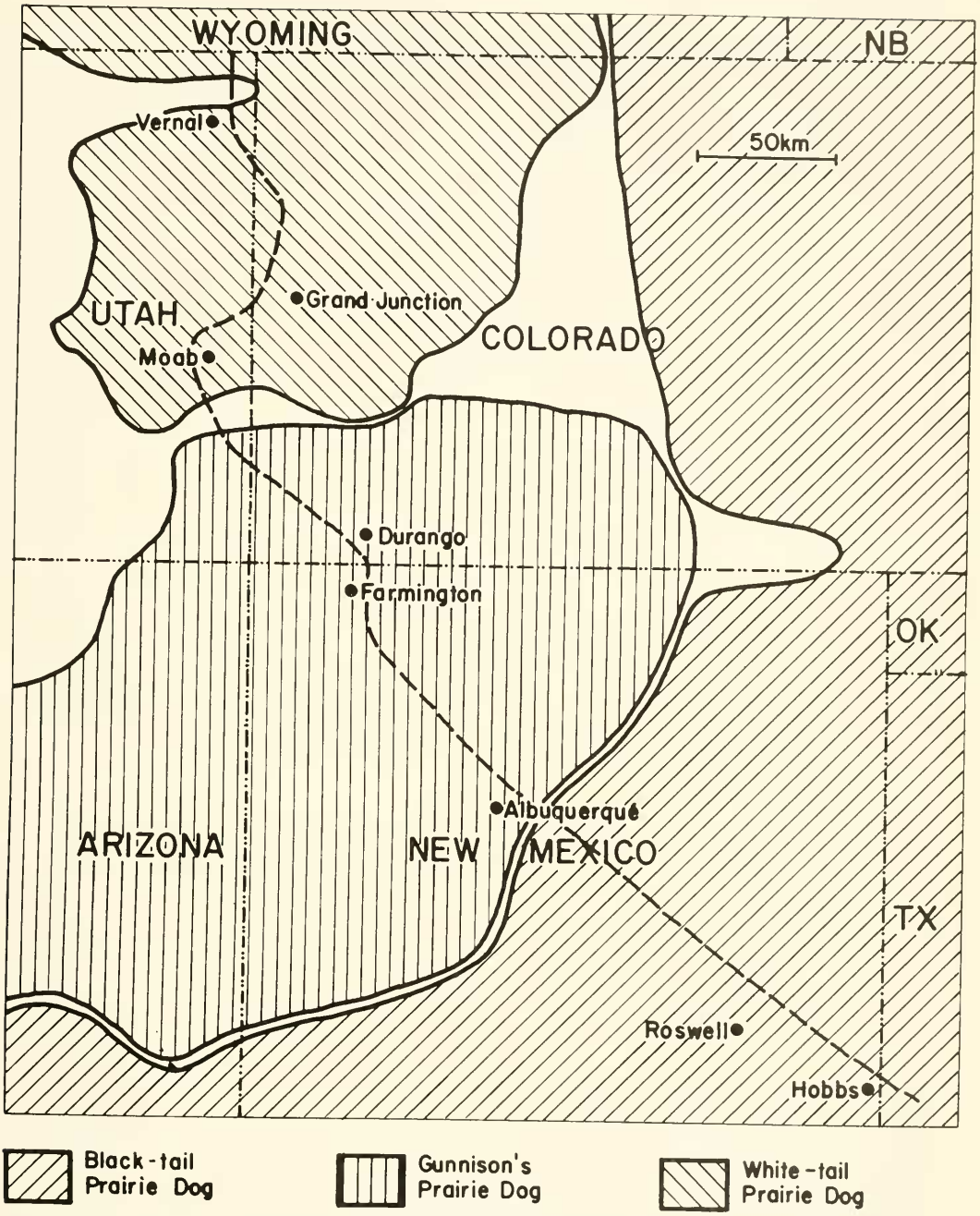

Fig. 1. Map of the three prairie dog species' distribution along the belt transect study area (dotted line) in New Mexico, Colorado, and Utah.

time spent walking; and number and species of all live vertebrates and their remains seen. Since badgers are considered the single most effective predator and directly alter a colony by digging, badger activity (percentage of burrows enlarged by badgers) was estimated on each colony (Campbell and Clark 1981).

Nocturnal surveys of prairie dog colonies were conducted via spotlighting. Two spotlights were used simultaneously by each

crew of two persons. One cab-mounted light was used by the driver and the second, hand-held light was used by the rider seated in back. The spotlights generally allowed identification of animals out to 150 m as the truck moved at 3–8 km/hr. Travel time around a spotlight circuit varied in relation to colony size and terrain, but was usually 15–60 minutes. On small towns (less than 10 ha) a single stationary spotlighting location was used. Spotlighting was started just after sunset and continued until around midnight and again from about 0300 hours till sunrise. All colonies were spotlighted for at least three consecutive nights, but large towns were spotlighted longer. All animals seen were identified to species and numbers recorded.

To compare the two nighttime survey periods for vertebrate activity and interobserver differentials, all vertebrates seen were lumped into classes based on taxonomy and morphology (primarily body size): (1) lagomorphs, (2) rodents, (3) flying vertebrates (birds and bats), (4) small carnivores (badgers and smaller forms), (5) large carnivores (coyotes and bobcats), and (6) ungulates. Lagomorphs, rodents, and flying vertebrates were compared between number of species seen on the first spotlight circuit of the post-sunset and predawn survey periods. All other classes were compared on number of species seen per hour over the entire survey periods.

RESULTS

Prairie Dog Colony Attributes

The 47 prairie dog colonies located totaled 4760 ha and comprised 2.2 percent of the belt transect (Table 1). Black-tails occupied 0.04 percent of the transect, Gunnison colonies 0.2 percent, and white-tail colonies 1.9 percent. Gunnison and white-tail colonies were clumped in distribution; information was insufficient to determine if black-tail colonies were also clumped.

The first three colonies encountered were black-tails, and intercolony distances between colony 1 and 2 and between 2 and 3 was 6.4 km and 86.3 km, respectively. Distance to the next colony, a Gunnison town, was 355 km. Gunnison colonies fell into four distinct clumps; 127 km separated the first (N = 6 towns) and second (N = 2 towns) clumps, 30.6 km the second and third (N = 2), and 245.5 km the third and fourth (N = 1).

TABLE 1. Comparative colony characteristics among the clumps of prairie dog colonies by prairie dog species.

Colony characteristics	Black-tails	Prairie Gunn-	
	Clump 1	Clump 1	Clump 2
Location	NW New Mexico		
Number of colonies	3	6	2
Total area (ha)	99	235	116
Colony area (ha):			
Mean (SD)	33(26)	39(27)	58(15)
Range	10–61	3–73	47–69
x̄ Intercolony distance (km)	46.4	2.3	3.2
Total burrow openings	2763	5238	1004
Burrow openings/ha:			
Mean (SD)	32.5(8.9)	209(8.4)	8.8(0.9)
Range	23.9–41.7	8.2–32.0	8.1–9.4
Plugged burrows: Number and % of all openings	106(3.8%)	13(0.2%)	4(0.3%)
Badger reamed: Number and % of total openings	102(3.4%)	366(7.8%)	65(6.8%)
Vertebrate skeletal remains:			
Prairie dogs/ha	0.273	0.196	0.078
Other species/ha	0.131	0.008	0.008
Vegetation (cm):			
x̄ Height (SD)	64(23)	79(29)	46(22)
Range	51–91	38–112	30–61

The mean intercolony distance for Gunnison colonies (N = 10) was 2.4 km (SD ± 1.6) range 0.5–5.3. The 33 white-tail colonies were distributed in two clumps. The first group of 15 towns was about 96 km from the nearest Gunnison colony and 115 km from the second white-tail colony group (N = 18). Mean intercolony distance for white-tails was 4.9 km (SD ± 3.0) range 0.8–11.3. Intercolony distances varied significantly interspecifically ($F_{2,37} = 17.92$, $P < 0.01$) and intraspecifically for white-tails ($X^2 = 56.14$, df = 31, $P < 0.005$).

The interspecific size of prairie dog colonies varied, but insignificantly ($F_{2,44} = 1.13$, $P > 0.05$). Three black-tail colonies had a mean size of 33 ha (SD ± 26) range 10–61, 11 Gunnison towns averaged 46 ha (SD ± 43) range 1.6–150, and 33 white-tail colonies averaged 125 ha (SD ± 200) range 0.2–958. A significant difference ($P < 0.05$) in mean colony size was evident within each of the three prairie dog species (black-tails $X^2 = 40.44$, df = 2; Gunnisons, $X^2 = 404.21$, df = 10; white-tails, $X^2 = 10245.69$, df = 32).

Plugged burrows were found in colonies of all three species. Black-tails showed 3.8 percent plugged of 2763 burrow openings, Gunnisons 0.3 percent of 8987 and white-tails 1.0 percent of 85,572. The interspecific density of burrow openings per colony varied insignificantly ($F_{2,44} = 1.09$, $P > 0.10$) among the three species, with black-tails showing 27.9/ha (SD ± 8.6, range 24–41.3), Gunnisons 17.6/ha (SD ± 49.2, range 8.2–179), and white-tails with 21/ha (SD ± 29.2, range 2.2 = 158).

All colonies showed signs of badger activity in the form of excavated holes and scats. Badger-reamed prairie dog holes (holes suspected of being enlarged by badger digging) on colonies varied significantly between the three prairie dog species ($F_{2,44} = 4.67$, $P < 0.05$). Badger activity was significantly lower on black-tail colonies than on Gunnison ($t = -7.42$, df = 12, $P < 0.01$) and white-tail colonies ($t = -8.69$, df = 34, $P < 0.01$), but was not significantly different on Gunnison and white-tail colonies ($t = -1.88$, df = 42, $P > 0.10$). Badger activity was positively and significantly correlated ($P < 0.01$) to colony size and to the number of burrow openings on each colony for both Gunnisons ($r = 0.8729$, $t = 5.37$ and $r = 0.9431$, $t = 8.51$, respectively) and white-tails ($r = 0.9084$, $t = 12.10$ and $r = 0.9845$, $t = 31.25$, respectively), but not for black-tails, nor were there

Table 1 continued.

dog species					
ison's			White-tails		
Clump 3	Clump 4	Total	Clump 1	Clump 2	Total
SW Colorado	E Utah	–	E Utah		–
2	1	11	15	18	33
10	150	511	566	3584	4150
5(4)	150	33(26)	38(37)	199(249)	125(200)
2–8	–	2–73	9–121	0.2–958	0.2–958
1.6	–	2.4	5.5	4.4	4.9
668	2077	8987	8993	76,579	85,572
96.2(69.1)	13.8(–)	31.7(39.4)	19.8(10.3)	30.8(37.6)	25.8(28.8)
47.3–145	–	8.1–145	2.3–40.5	5.1–160	2.3–160
0	8(0.4%)	25(0.3%)	23(0.3%)	40(0.3%)	790(0.9%)
50(7.2%)	235(11.3%)	716(7.8%)	769(9.3%)	16,469(17.5%)	17,238(13.8%)
0.90	0.287	0.209	0.150	0.159	0.157
0.30	0.012	0.018	0.0179	0.0209	0.020
84(32)	61	673(28)	39(23)	46(15)	42.6(19)
61–107	–	30–112	0–91	15–71	0–91

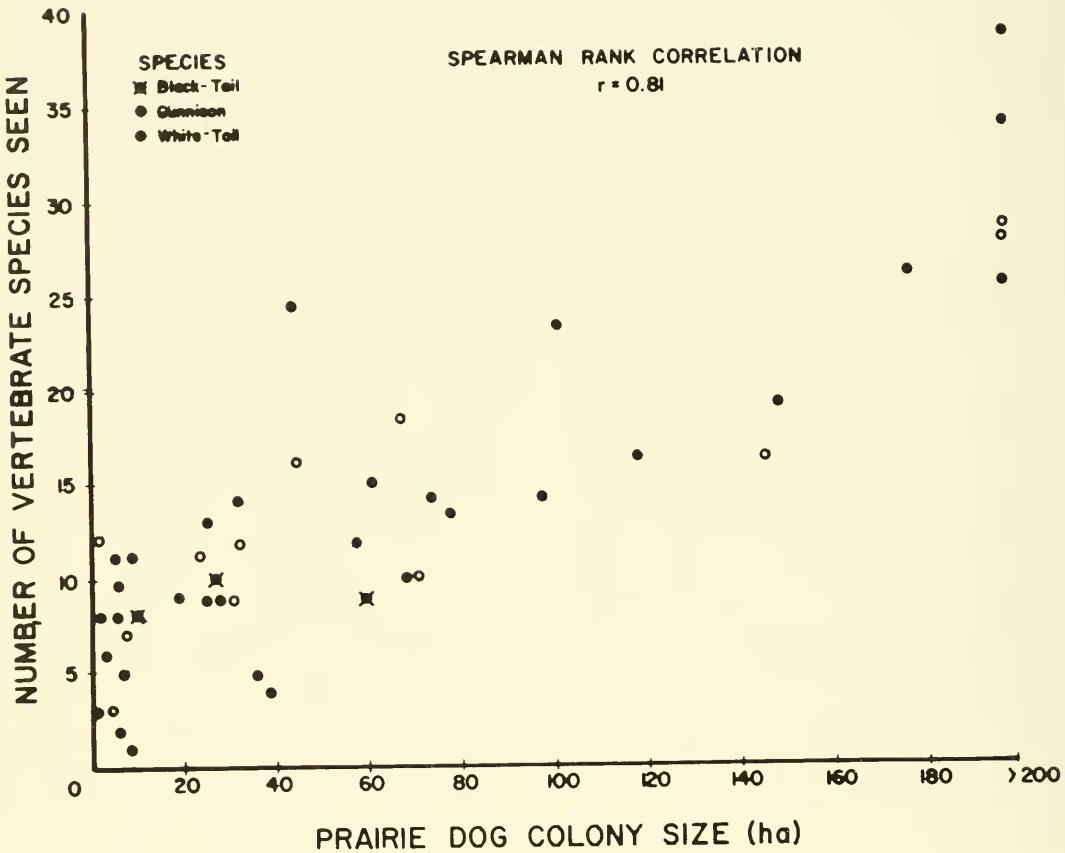

Fig. 2. Relationship between black-tail, Gunnison, and white-tail prairie dog colony size and number of vertebrate species observed on each colony.

significant correlations with burrow density or intercolony distances.

Associated Vertebrate Species

A total of 107 species and subspecies, vertebrate animals, including one amphibian, 25 reptiles, 51 birds, and 30 mammals, were observed on prairie dog colonies (Table 2). A larger number of vertebrate species were seen on white-tailed colonies than on colonies of the other two prairie dog species; 88 percent of the surface area of all prairie dog colonies was in white-tail colonies.

Six species of mammals, 7 species of birds, 2 species of reptiles, and no species of amphibians were common to colonies of all three prairie dog species. In contrast, 7 mammal, 11 bird, 8 reptile, and no amphibian species were common to colonies of two prairie dog species, and 17 mammal, 33 bird, 15 reptile, and one amphibian species were present on colonies of only one prairie dog species.

The relationship between the number of vertebrate species seen on prairie dog colonies of varying sizes is shown in Figure 2. A Spearman Rank Correlation ($r = .81$) showed that larger towns contained more vertebrate diversity than smaller colonies.

Four rattlesnake species and subspecies were found, 1 western diamondback, 4 Hopi, 7 prairie, and 6 midget-faded rattlesnakes. Rattlesnakes on black-tail colonies occurred at 0.02/ha, on Gunnison at 0.02/ha, and on white-tail at 0.002/ha. The Hopi were on a single 148 ha Gunnison colony.

Eleven raptor species, including one eagle, 4 hawks, 3 falcons, and 3 owls, were seen. Burrowing owls ($N = 99$) occurred on 19 towns and at a density of 0.04 owls/ha. The greatest density was 15 owls on a 10 ha town.

TABLE 2. Vertebrate species and subspecies observed on the colonies of three prairie dog species in New Mexico, Colorado, and Utah.

Vertebrate species and subspecies	Prairie dog species		
	Black-tail	Gunnison	White-tail
AMPHIBIANS			
Great Basin spadefoot toad (*Scaphiopus intermontanus*)			X
Totals	0	0	1
REPTILES			
Mountain short-horned lizard (*Phrynosoma douglassi hernandesi*)			X
Eastern short-horned lizard (*P. douglassi brevirostre*)			X
Desert short-horned lizard (*P. douglassi ornatissimum*)		X	X
Texas horned lizard (*P. cornutum*)	X		
Sagebrush lizard (*Sceloporus grasiosus*)	X	X	X
Northern plateau lizard (*S. undulatus elongatus*)			X
Northern whiptail (*Cnemidophorus tigris septentrionalis*)			X
Western whiptail (*C. tigris*)		X	X
Little striped whiptail (*C. inornatus*)	X	X	
Chihuahua whiptail (*C. exsanguis*)	X	X	
Checkered whiptail (*C. tesselatus*)		X	
Leopard lizard (*Crotaphytus wislizenii*)			X
Lesser earless lizard (*Holbrookia maculata*)	X	X	X
Side-blotched lizard (*Uta stansburiana*)		X	X
Western coachwhip (*Masticophis flagellum testaceus*)		X	
Great Basin gopher snake (*Pituophis melanoleucus deserticola*)		X	X
Bullsnake (*P. m. sayi*)		X	
Utah milk snake (*Lampropeltis triangulum taylori*)			X
Wandering garter snake (*Thamnophis elegans vagrans*)			X
Painted desert glossy snake (*Arizona elegans philipi*)		X	
Western diamondback rattlesnake (*Crotalus atrox*)		X	
Midget faded rattlesnake (*C. viridis concolor*)		X	X
Prairie rattlesnake (*C. v. viridis*)	X	X	
Hopi rattlesnake (*C. v. nuntius*)		X	
Western box turtle (*Terrapene ornata*)	X		
Totals (n = 25)	6	16	15
BIRDS			
Canada Goose (*Branta canadensis*)			X
Mallard (*Anas platyrhynchos*)			X
Green-winged Teal (*Anas crecca*)			X
Turkey Vulture (*Cathartes aura*)			X
Marsh Hawk (*Circus cyaneus*)			X
Red-tailed Hawk (*Buteo jamaicensis*)		X	X
Ferruginous Hawk (*B. regalis*)	X	X	X
Swainson's Hawk (*B. swainsoni*)	X		
Golden Eagle (*Aquila chrysaetos*)			X
Prairie Falcon (*Falco mexicanus*)			X
Merlin (*F. columbarius*)			X
Kestrel (*F. sparverius*)	X	X	X
Short-eared Owl (*Asio flammeus*)			X
Great Horned Owl (*Bubo virginianus*)			X
Burrowing Owl (*Athere cunicularia*)	X	X	X
Sage Grouse (*Centrocercus urophasianus*)			X
Gambel's Quail (*Lophortyx gambelii*)		X	
Killdeer (*Charadrius vociferus*)		X	X
Western Sandpiper (*Calidris mauri*)			X
Mourning Dove (*Zenaida macroura*)	X	X	X
Common Nighthawk (*Chordeiles minor*)		X	X
Lesser Nighthawk (*C. acutipennis*)		X	X
Poor-will (*Phalaenoptilus nuttallii*)			X

Table 2 continued.

Vertebrate species and subspecies	Prairie dog species		
	Black-tail	Gunnison	White-tail
BIRDS continued.			
Western Kingbird (*Tyrannus verticalis*)		X	X
Say's Phoebe (*Sayornis saya*)		X	X
Gray Flycatcher (*Empidonax wrightii*)			X
Ash-throated Flycatcher (*Myiarchus cinerascens*)		X	
Horned Lark (*Eremophila alpestris*)	X	X	X
Violet-green Swallow (*Tachycineta thalassina*)			X
Barn Swallow (*Hirundo rustica*)			X
Rough-winged Swallow (*Stelgidopteryx ruficollis*)			X
Pinyon Jay (*Gymnorhinus cyanocephalus*)		X	
Black-billed Magpie (*Pica pica*)			X
Common Raven (*Corvus corax*)		X	X
Rock Wren (*Salpinctes olsoletus*)			X
Sage Thrasher (*Oreoscoptes montanus*)		X	X
Curve-billed Thrasher (*Toxostoma curvirostre*)	X		
Mockingbird (*Mimus polyglottos*)		X	X
Mountain Bluebird (*Sialis currucoides*)		X	X
Northern Shrike (*Lanius excubitor*)			X
Loggerhead Shrike (*L. ludovicianus*)			X
Western Meadowlark (*Strunella neglecta*)	X	X	X
Eastern Meadowlark (*S. magna*)		X	
Brewer's Blackbird (*Euphagus cyanocephalus*)			X
Western Tanager (*Piranga lucoviciana*)			X
Grasshopper Sparrow (*Ammodramus savannarum*)			X
Vesper Sparrow (*Pooecetes gramineus*)			X
Black-throated Sparrow (*Amphispiza bilineata*)		X	
Sage Sparrow (*A. belli*)		X	X
Lark Sparrow (*Chondestes grammacus*)	X	X	X
Brewer's Sparrow (*Spizella breweri*)			X
Totals (n = 51)	9	23	44
MAMMALS			
Bat (unidentified)		X	X
Desert cottontail (*Sylvilagus auduboni*)	X	X	X
Mountain cottontail (*S. nuttalli*)		X	X
White-tailed jackrabbit (*Lepus townsendi*)			X
Black-tailed jackrabbit (*L. californicus*)	X	X	X
Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)	X		X
Wyoming ground squirrel (*S. elegans*)			X
Whitetail antelope squirrel (*Ammospermophilus leucurus*)		X	
Pocket gopher (*Thomomys* sp.)		X	
Valley pocket gopher (*T. bottae*)			X
Plains pocket gopher (*Geomys bursarius*)	X		
Least chipmunk (*Eutamius minimus*)			X
Woodrat (*Neotoma* sp.)		X	
Bushytail woodrat (*N. cinerea*)			X
Southern plains woodrat (*N. micropus*)	X		
Ord kangaroo rat (*Dipodomys ordi*)	X	X	X
Bannertail kangaroo rat (*D. spectabilis*)		X	
Deer mouse (*Peromyscus maniculatus*)			X
Vole (*Microtus* sp.)			X
Muskrat (*Ondatra zibethica*)			X
Coyote (*Canis latrans*)	X	X	X
Swift fox (*Vulpes velox*)		X	X
Domestic dog (*Canis familiarus*)		X	X
Domestic cat (*Felis domesticus*)		X	
Long-tailed weasel (*Mustela frenata*)	X		X

Table 2 continued.

Vertebrate species and subspecies	Prairie dog species		
	Black-tail	Gunnison	White-tail
MAMMALS continued.			
Short-tailed weasel (*M. erminea*)			X
Badger (*Taxidea taxus*)	X	X	X
Striped skunk (*Mephitis mephitis*)			X
Mule deer (*Odocoileus hemionus*)		X	X
Pronghorn (*Antilocapra americana*)	X	X	X
Totals (n = 30)	10	16	23

Only two live weasels were found, a bridled weasel in New Mexico (61 ha town) and a short-tailed weasel in Utah (102 ha town). Both were sighted in daylight.

Fourteen live badgers were seen on 10 colonies (1 badger/183 ha, range 0.2–522). All badgers were the sole mustelid species seen on its respective town except for 5 badgers on a 946 ha town (1 badger/189 ha). All towns showed signs of badger activity, although varying greatly in density.

Coyotes (N = 29) were seen on 18 towns (1 coyote/115 ha). An additional 12 towns had coyote scats. Kit foxes (N = 5) were seen on 4 towns that had a mean size of 62 ha (range 20–148). Two foxes were on a 26 ha town.

Numerous vertebrate remains were found on prairie dog towns (Table 1). In all, 1597 remains of individual prairie dogs and 202 other vertebrate remains of at least 16 species were found. Prairie dog remains occurred at about one skeleton/5 ha and remains of other vertebrates at about 1/50 ha.

Nocturnal survey results showed that some vertebrates had a differential observability between the postsunset and predawn survey periods. The front and back spotlight personnel observed species and categories of vertebrates differentially. Three categories of vertebrate sightings—flying forms ($X^2 = 159$, $df = 1$, $P < 0.01$), ungulates ($X^2 = 11$, $df = 1$, $P < 0.01$), and large carnivores ($X^2 = 10.5$, $df = 1$, $P < 0.05$)—showed significant differences in observability, which may reflect real differences in activity, with most being seen per unit effort in postsunset periods.

Rodents ($X^2 = 18.8$, $df = 1$, $P < 0.01$) and flying vertebrates ($X^2 = 45.1$, $df = 1$, $P < 0.01$) were sighted significantly more by the driver than the rider in back. The driver and rider saw no significant differences between all other classes.

DISCUSSION

Prairie dog colonies occupied only a small portion of the survey area (2.2 percent); less than 1 percent for black-tail and for Gunnison and about 1.9 percent for white-tail. The U.S. Forest Service (1981) found black-tails on Thunder Basin National Grassland, Wyoming, to occupy 1.3 percent. Elsewhere in Wyoming, Campbell and Clark (1981) found black-tails to occupy only 0.7 percent of a 1036 km² and white-tails 3.2 percent of 336 km². An area in southwest Wyoming contained 63 white-tail towns and occupied 25 percent of the 259 km² area (Clark and Campbell, unpubl. ms.). White-tails in two other areas in southern Wyoming occupied 7.2 percent and 8.9 percent of the study area (Martin and Schroeder 1979, 1980) (Table 3).

In comparing the three black-tail colonies in our study with 186 other black-tail towns elsewhere, our 11 Gunnisons with one other, and our 33 white-tail towns with 354 others (Table 3), all the towns we surveyed fall within the ranges of colony sizes and burrow opening features previously reported. Our survey of Gunnison prairie dogs appears to be the first relatively large sample. We found a mean intercolony distance of 46.4 km for black-tails, 2.4 km for Gunnisons and 4.9 km for white-tails, whereas Campbell and Clark (1981) found 4.7 km (SD ± 2.7) range 1.6–11.3 for white-tails in two large relatively undisturbed areas in Wyoming.

Prairie dog colonies were found clumped in suitable habitat, and nearby colonies served as sources for colonizing animals. White-tail colonies (N = 19) in the Vernal, Utah, clump were part of a much larger complex of colonies estimated to be at least 5,000 ha. No comparable situation for the black-tail or Gunnison was found.

Prairie dogs are known to plug burrows in response to predator investigations, death of prairie dogs, and other disturbances (Koford 1958, Henderson et al. 1969). We found black-tails plugged 3.8 percent of their burrow openings, Gunnisons 0.2 percent and white-tails 0.9 percent. In comparison, Campbell and Clark (1981) found 0.0005 percent plugged burrow openings for black-tails and 0 percent for white-tails in Wyoming.

Gold (1976), Bonham and Lerwick (1976), and Hansen and Gold (1977) noted that black-tail prairie dogs manipulate soil and increase plant and animal density and therefore may be viewed as ecosystem regulators. Uresk and Bjugstad (in press) noted that peak plant production of aboveground herbage over their five-year study occurred where prairie dogs only grazed during the last four years of the study, rather than under the other comparative treatments (prairie dogs and steers, steers only, neither).

Our surveys found 107 vertebrate species and subspecies on or over prairie dog colonies. Additional species occupying prairie dog colonies were reported by Tyler (1968), Martin and Schroeder (1979, 1980), and Campbell and Clark (1981). Collectively, over 140 vertebrate species have been reported associated with prairie dogs.

A general account of many of the more conspicuous vertebrates and their interrelationships with prairie dogs was discussed by Koford (1958). Prairie dogs improve habitat for prairie animals that are benefited by holes, unvegetated areas, and short vegetation and for those that feed on prairie dogs. The prairie dog burrow is a critical element in prairie dog survival and allows them to escape the extremes of temperature, for example, and benefits numerous other vertebrates as well (Stromberg 1978). Desert cottontails, burrowing owls, swift foxes, rattlesnakes, and some species of plants are enhanced by prairie dog activities (Uresk and Bjugstad, in press). Sixty-three percent more small mammals, other than prairie dogs, were live-trapped on pastures used by steers and prairie dogs than on steer-only pastures (O'Melia 1980). O'Melia also found prairie dogs significantly decrease arthropod populations.

TABLE 3. Prairie dog colony characteristics for black-tail, white-tail, and Gunnison prairie dog species found in this and other studies conducted in Wyoming, Colorado, Montana, Kansas, and South Dakota.

Prairie dog species and location	Number of colonies	Colony area (ha)	
		Total	$\bar{x}$ (SD) range
BLACK-TAIL PRAIRIE DOG			
Southeast New Mexico	3	99	33(26)10–61
Central Wyoming	21	731	35(44)1–189
Eastern Wyoming	2	123	66(--)26–97
Central South Dakota	151	1,283	8.5(--)--
Western South Dakota	2	–	--(--)--
Northern Colorado	1	3	3(--)--
Great Plains	–	–	--(--)--
Central Kansas	1	47	47(--)--
Northern Wyoming	7	580	83(--)2.8–359
GUNNISON PRAIRIE DOG			
Northeast New Mexico	11	511	33(26)2–73
Southwest Colorado	1	6	6(--)--
WHITE-TAIL PRAIRIE DOG			
Eastern Utah	33	4,150	125(200)0.2–958
South central Wyoming	25	1,085	43(46)2–184
Northwest Wyoming	4	3,055	764(--)121–1416
Southwest Wyoming	63	3,992	63(--)0.4–671
South central Wyoming	1	13	13(--)--
Southern Wyoming	164	4,006	24(--)0.8–510
Southern Wyoming	81	60,665	54(--)0.4–414
Southern Montana	15	285	19(--)----
North central Colorado	1	9	9(--)--

Prairie dogs provide food to the black-footed ferret (Hillman and Clark 1980), badgers, foxes, coyotes, bobcats, and weasels as well as to Golden Eagles, Ferruginous Hawks, and Swainson's Hawks (Campbell and Clark 1981). The U.S. Bureau of Land Management (1979) noted that prairie dog towns also provide nest sites for Mountain Plovers (*Charadrius montanus*) and McCown's Longspur (*Calcarius mccownii*) and benefit other birds such as Killdeer, Eastern Kingbirds (*Tyrannus tyrannus*), Upland Sandpiper, Long-billed Curlews (*Numenius americanus*) and Mourning Doves, to mention a few. Sharp-tailed (*Pedioecetes phasianollus*) and Sage grouse sometimes strut on prairie dog towns (McEneany and Jensen 1974). A large number of reptiles use prairie dog holes for thermoregulation and protection from predators. Reptiles eat arthropods inhabiting both burrows and the surface of the colony (Wilcomb 1954, Clark 1977).

Evidence of human presence—roads, spent shell casings, plowing, and some evidence of poisoning—was obvious on many colonies. Our observations in this study and elsewhere indicate that most prairie dog colonies are negatively influenced by humans; only a few areas still contain large, relatively undisturbed colonies.

This brief account of prairie dog colony attributes and the relationships of some associated vertebrate species with prairie dogs shows that numerous benefits may be accrued to some of those vertebrates. Prairie dog colonies may constitute peaks in species diversity and biomass for small vertebrates found nowhere else in the prairie ecosystem. Needed are precise community ecology studies, with adequate controls near prairie dog towns, to quantify relative degrees of association between the various vertebrate species and prairie dogs and to identify the types of relationships that exist.

ACKNOWLEDGMENTS

Many people provided direct aid to this project. James Leiber and Gene Bell of Mid-America Pipeline Co., Inc., Tulsa, Oklahoma, provided the opportunity and support for the survey. Dana Shuford, U.S. Bureau of Land

Table 3 continued.

Burrow openings				
	Density/ha			
Total	x̄ (SD) Range	Percent plugged	Percent badger reamed	Sources
2,763	33(9)24–42	3.8	3.4	This study
17,095	21(24)11–67	0.0	10.0	Campbell & Clark 1981
6,015	49(10)38–52	0.9	2.6	Clark & Campbell unpubl.
—	—(—)—	—	—	Linder et al. 1972
—	135(—)131–140	—	—	King 1955
289	96(—)—	—	—	Tileston & Lechleitner 1966
—	5(—)15–67	—	—	Koford 1958
6,344	135(—)—	—	—	Smith 1958
29,215	50(—)—	2.2	—	Martin & Schroeder 1980
8,987	32(39)8–145	2.8	7.8	This study
321	57(—)—	—	—	Fitzgerald & Lechleitner 1974
85,572	26(29)2–160	0.9	13.8	This study
27,779	25(26)9–129	0.0	27	Campbell & Clark 1981
6,755	2.2(—)1–6	—	—	Clark et al. unpubl.
168,761	42(—)0.7–21.3	—	24.7	Clark & Campbell unpubl. and Martin & Schroeder 1979, 1980
827	64(—)—	—	—	Clark 1977
105,497	26(—)0.8–41	—	—	Martin & Schroeder 1979
129,969	32(—)—	4.3	—	Martin & Schroeder 1980
—	—(—)—	—	—	Flath 1979
252	28(—)—	—	—	Tileston & Lechleitner 1966

Management, helped facilitate the project. Janice Hutton, David Hayden, and Ron Freeman of Woodward/Clyde Consultants, San Francisco, California, provided administrative and field assistance.

In addition to ourselves, survey teams consisted of Marcia Casey, Janette Johnson, Cheryl Lorenz, Suzanne Martell, Ronald Pace, Anne Rathbun, Sue Wandersee, JoAnn Camenzind, Marilyn McElheney, Kane Brightman, John Hoak, and Karen Jerger. Their untiring efforts, keen observations, and total commitment to a quality survey were invaluable. We would like to thank Jeff Marks for aiding with bird names. We sincerely thank all those people who directly aided in the survey and many others not mentioned by name who helped indirectly.

LITERATURE CITED

BONHAM, D. C., AND A. LERWICK. 1976. Vegetation changes induced by prairie dogs on shortgrass range. J. Range Manage. 27:221–225.

CAMPBELL, T. M., AND T. W. CLARK. 1981. Colony characteristics and vertebrate associates of white-tailed and black-tailed prairie dogs in Wyoming. Am. Midl. Nat. 105:269–276.

CLARK, T. W. 1977. Ecology and ethology of the white-tailed prairie dog (*Cynomys leucurus*). Milwaukee Public Mus. Publ. Biol. Geol. No. 3. 97 pp.

FITZGERALD, J. P., AND R. R. LECHLEITNER. 1974. Observations on the biology of Gunnison's prairie dog in central Colorado. Am. Midl. Nat. 92:146–163.

FLATH, D. L. 1979. Status of the white-tailed prairie dog in Montana. Proc. Mont. Acad. Sci. 38:63–67.

GOLD, I. K. 1976. Effects of blacktail prairie dog mounds on shortgrass vegetation. Unpublished thesis. Colorado State Univ., Fort Collins, Colorado. 39 pp.

HANSEN, R. M., AND I. K. GOLD. 1977. Blacktail prairie dogs, desert cottontails, and cattle trophic relations on shortgrass range. J. Range Manage. 30:210–214.

HENDERSON, F. R., P. F. SPRINGER, AND R. ADRIAN. 1969. The black-footed ferret in South Dakota. South Dakota Dept. Game, Fish, and Parks Tech. Bull. 4. 37 pp.

KING, J. A. 1955. Social behavior, social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Univ. Michigan Contrib. Lab. Vert. Biol. 67:1–123.

KOFORD, C. B. 1958. Prairie dogs, whitefaces, and blue grama. Wildl. Monogr. No. 3. 78 pp.

LINDER, R. L., R. B. DAHLGREN, AND C. N. HILLMAN. 1972. Black-footed ferret-prairie dog interrelationships. Pages 22–37 *in* Symp. Rare and Endangered Wildl. of the SW U.S., Sept. 22–23, 1972. Albuquerque, New Mexico.

MARTIN, S. J., AND M. H. SCHROEDER. 1979. Black-footed ferret surveys on seven coal occurrence areas in southwestern and southcentral Wyoming, June 8 to September 25, 1978. Final report, Wyoming State Office BLM. 37 pp.

_____. 1980. Black-footed ferret surveys on seven coal occurrence areas in Wyoming, February–September, 1969. Final report, Wyoming State Office BLM. 39 pp.

MCENEANY, T. P., AND J. L. JENSEN. 1974. Status of the black-tailed prairie dog on the Charles M. Russell National Wildlife Refuge. USFWS. Lewiston, Montana. 7 pp.

O'MELIA, M. E. 1980. Competition between prairie dogs and beef cattle for range forage. Unpublished thesis. Oklahoma State Univ., Stillwater, Oklahoma. 33 pp.

PIZZIMENTI, J. J. 1981. Increasing sexual dimorphism in prairie dogs: evidence for changes during the past century. Southw. Nat. 26:43–47.

SMITH, R. E. 1958. Natural history of the prairie dog in Kansas. Univ. Kans. Mus. Nat. Hist. and St. Biol. Surv. Misc. Publ., 16:1–36.

STROMBERG, M. R. 1978. Subsurface burrow connections and entrance spatial pattern of prairie dogs. Southw. Nat. 23:173–180.

TILESTON, J. V., AND R. R. LECHLEITNER. 1966. Some comparisons of the black-tailed and white-tailed prairie dog in north central Colorado. Am. Midl. Nat. 75:292–316.

TYLER, J. D. 1968. Distribution and vertebrate associates of the black-tailed prairie dog in Oklahoma. Unpublished dissertation. Univ. of Oklahoma, Norman, Oklahoma. 85 pp.

WILCOMB, M. J. 1954. A study of prairie dog burrow systems and the ecology of their arthropod inhabitants in central Oklahoma. Unpublished dissertation. Univ. of Oklahoma, Norman, Oklahoma. 154 pp.

URESK, D. W., AND A. J. BJUGSTAD. Effects of prairie dogs and cattle on the vegetation of the northern high plains. Proc. 7th No. Amer. Prairie Conf. (in press).

U.S. BUREAU OF LAND MANAGEMENT. 1979. Habitat management plan-prairie dog ecosystem. Montana State Office, Billings, Montana. 61 pp.

U.S. FOREST SERVICE. 1981. Thunder Basin prairie dog management. USDA. Environmental Assessment. Thunder Basin Nat. Grasslands, 809 South 9th St., Douglas, Wyoming 82633.